Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

O_3 sensitivity by reducing emissions of precursors in Barcelona

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Madrid, Nov 20-21, 2018

Workshop on air quality policy implementation related to ozone

The CALIOPE air quality forecast system

www.bsc.es/caliope

METEO

- **WRF-ARWv3.5** (RRTM/WSM3/YSU/NoahLSM)
- Ver. Res.: 37σ/50hPa (top)
- Hor. Res: 12km (EU) - 4km (IP) - 1km (CAT,MAD,etc)
- IC/BC (EU12/IP4): GFS (NCEP) / nesting EU12

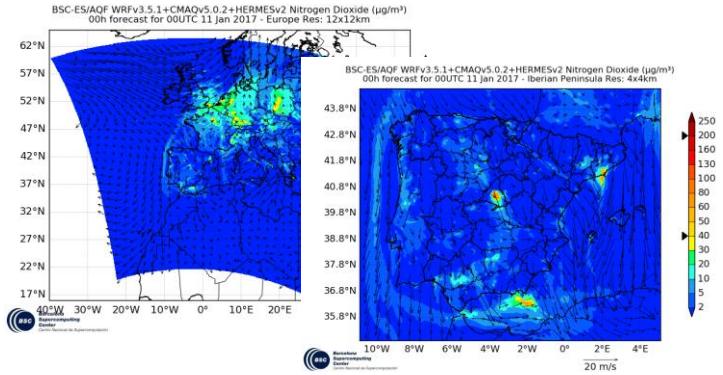
EMIS

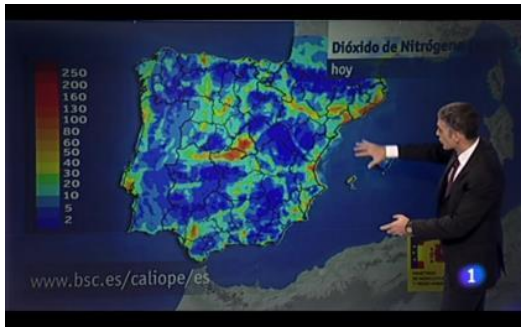
- **HERMESv2.0 and v3.0**
- EU12: HERMES-DIS (EMEP, TNO-MACC)
- IP4: HERMES-BOUP (Spain) + HERMES-DIS(Europe)
- Biogenic emission MEGANv2.0.4

CHEM

- **CMAQv5.0.2** (ISAM, CB05TUCL, AERO6)
- Ver. Res: 37σ / 50hPa (top)
- Hor. Res: 12km (EU) - 4km (IP) - 1km (CAT,MAD,etc)
- BC (EU12/IP4): MOZART4-GEOS-5 & CAMS
- MCIPv4.0

Air quality products





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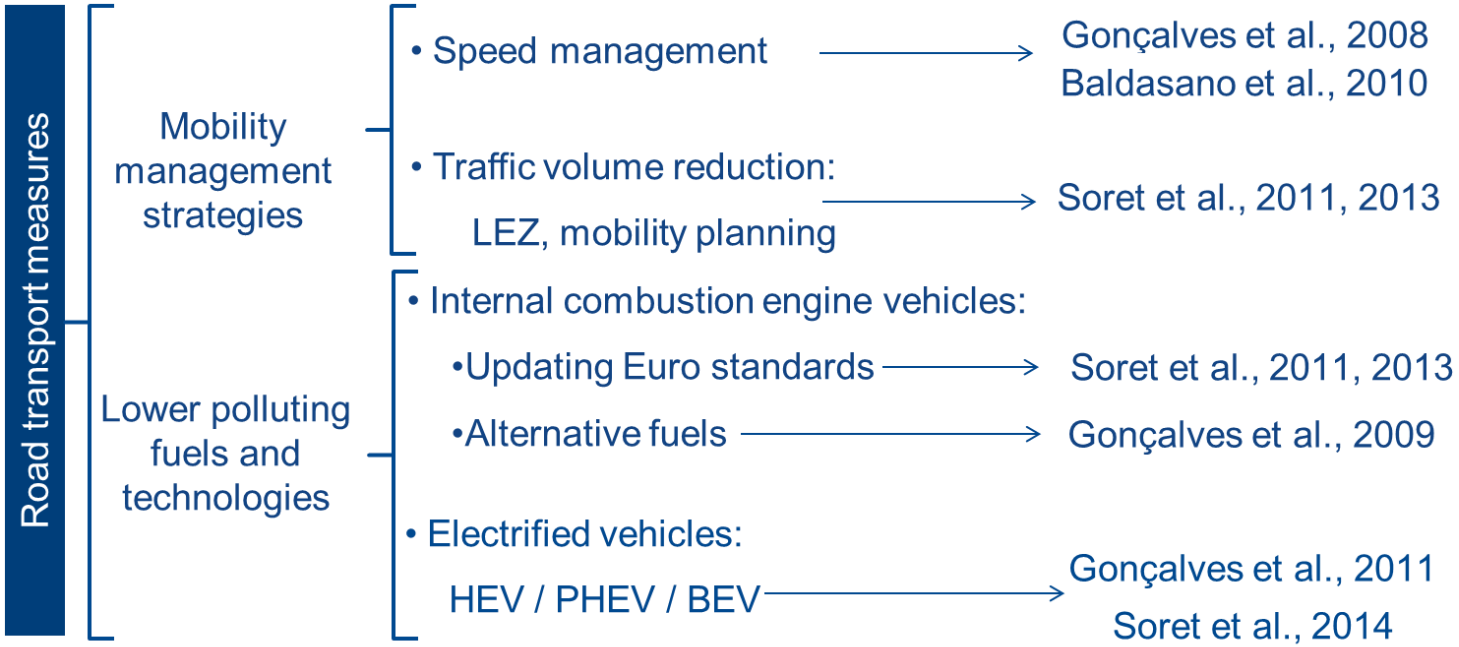
CALIOPE for mitigation strategies

Modelling approach – Earth Science Department @BSC



- Targeting Barcelona & Madrid cities: different regimes (chemical, meteorological).
- Focused on the road traffic sector (PM10, PM2.5 and NO_2).
- Impact on NO_2 and PM: reduction in the conurbations (up to 30%).
- Impact on O_3: slightly increase in the urban area (~1-4%) and low and negligible downwind.

What remains? Diagnosis of O_3 problem

1

STATE

- Which are the economic activities **(sectors)** responsible for high O_3?
- Where do the precursors responsible for O_3 exceedances come from **(regions)**?

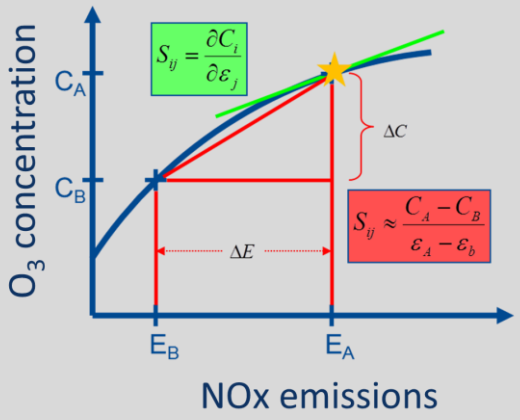
Source apportionment

2

RESPONSE

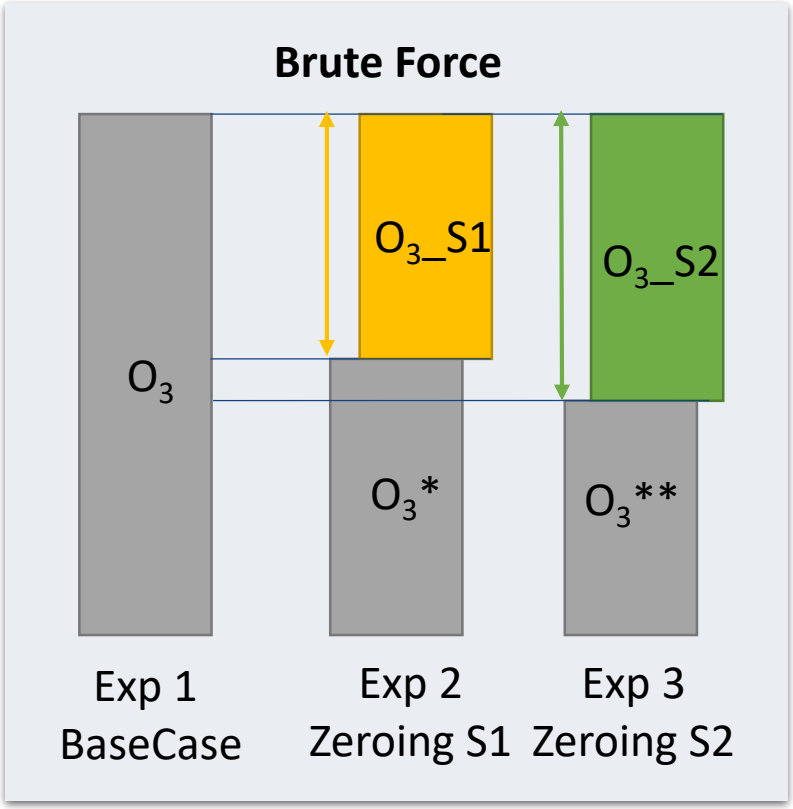
- Which sources (sectors/regions) are more efficient to reduce?
- Counterpart of NO_x/VOC reduction on O_3

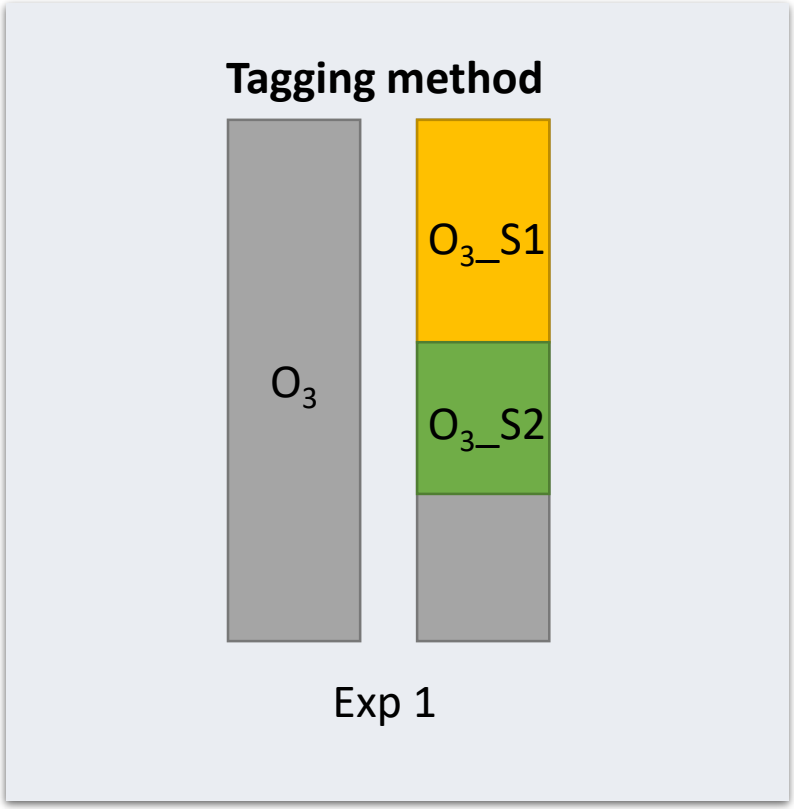
Source sensitivity



Source apportionment

Emission are critical





+ Straightforward for any model
- Mass inconsistency
- Not real atmospheric conditions
- High computational resources

+ Time saving (one simulation)
+ Mass consistency
+ Real atmospheric conditions
+ Appropriate secondary pollutant (O_3)
- Model coding required

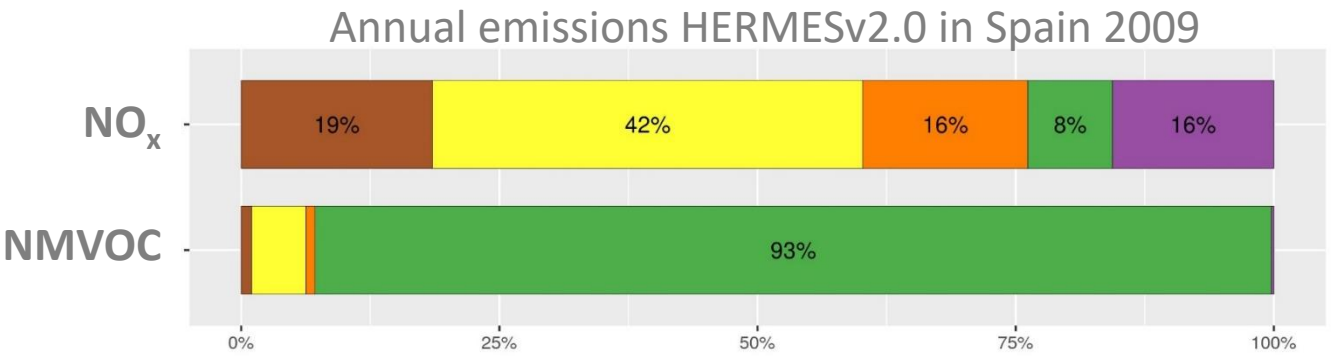
CALIOPE system (CMAQ-ISAM)

Exp: sector emissions + imported O_3

Pay et al., 2018. Atmos. Chem. Phys. Diss.

Experiment set-up

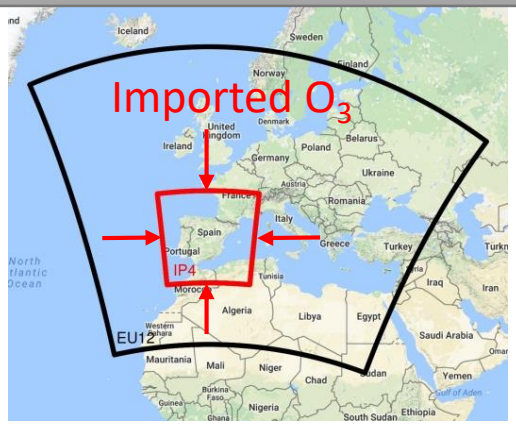
Which sources?



Sectors that account 92% of the total NO_x

- Others
- Power Plants
- Industry
- On-road transport
- Non-road transport

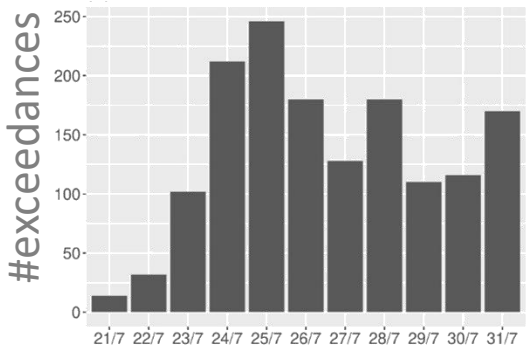
Imported O_3 from where?

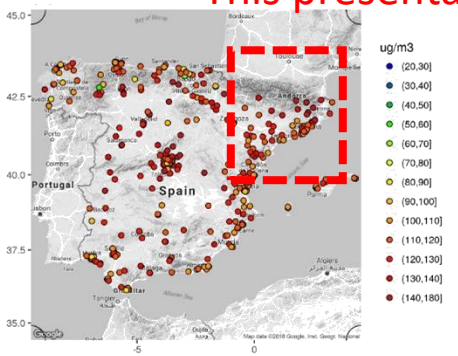


The episode

21-31 July 2012

This presentation





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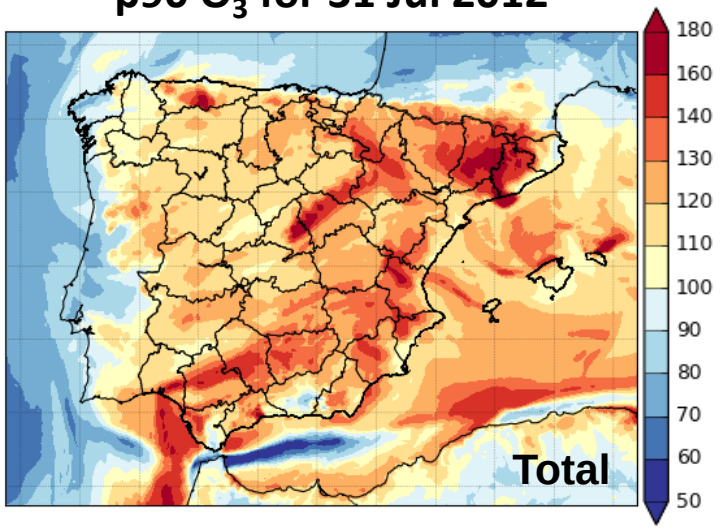
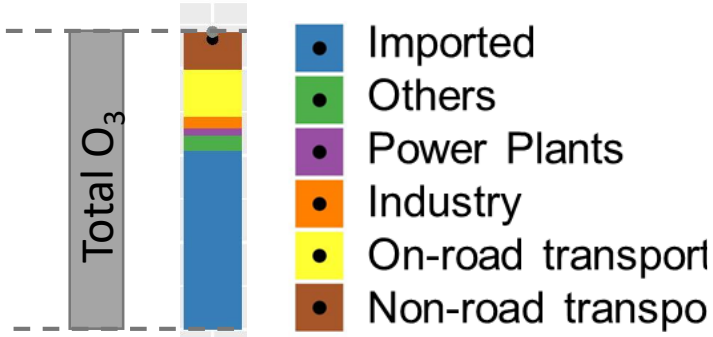
Exp: sector emissions + imported O_3

Pay et al., 2018. Atmos. Chem. Phys. Diss.

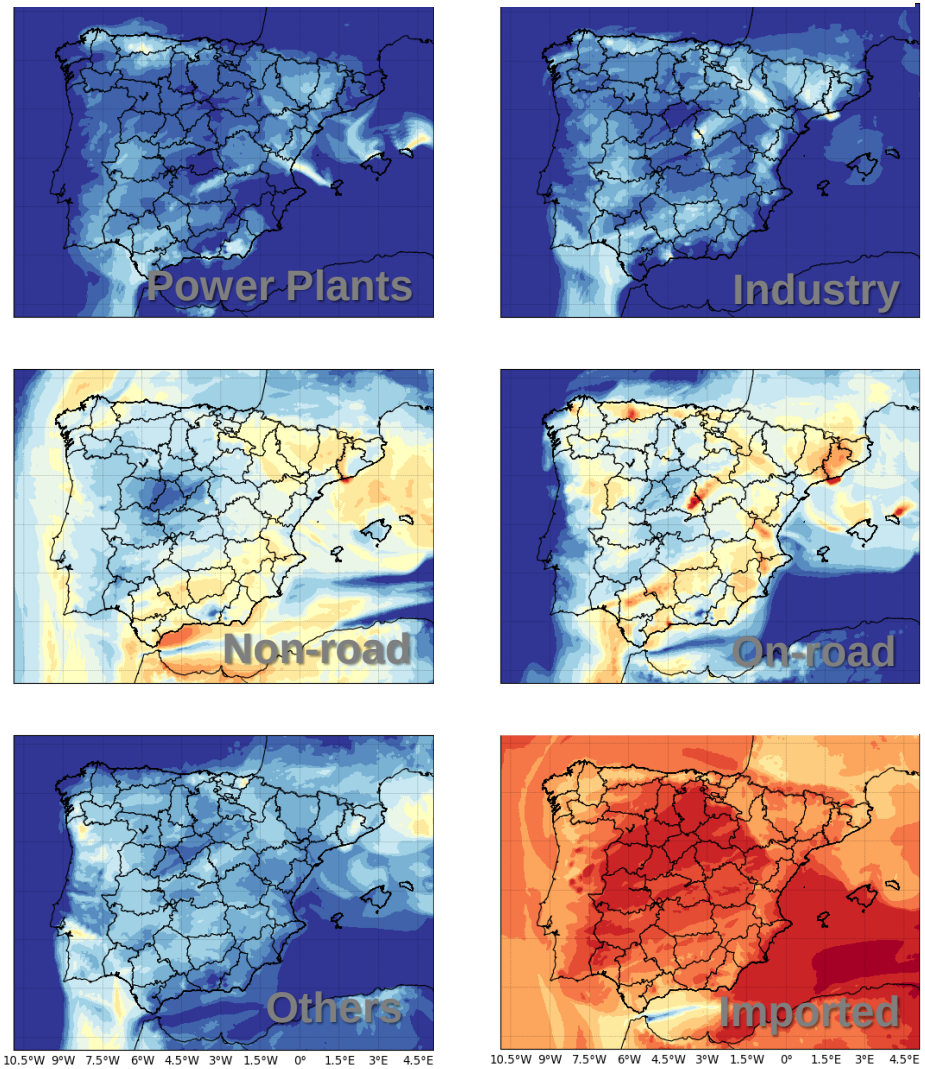
p90 O_3 for 31 Jul 2012



Tagging method



p90 O_3 contributions for 31 Jul 2012



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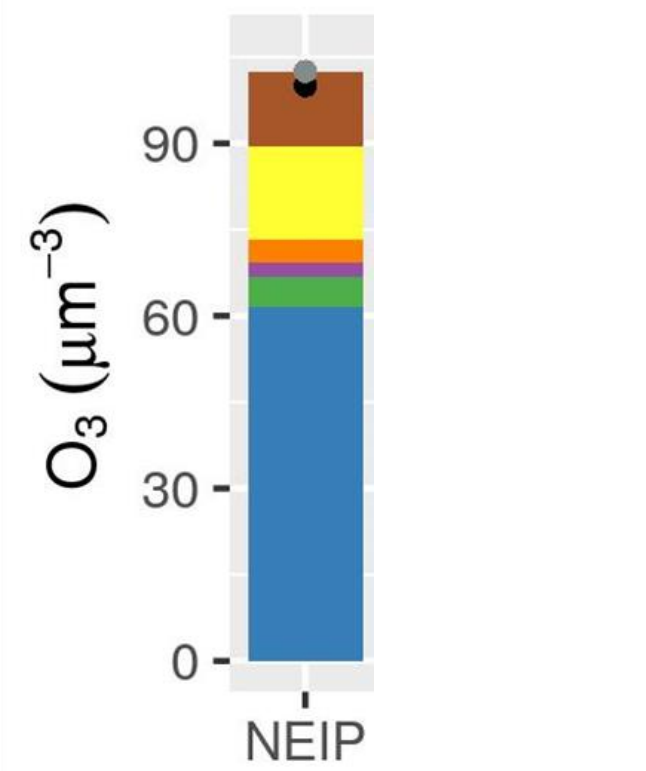
Exp: sector emissions + imported O_3

Pay et al., 2018. Atmos. Chem. Phys. Diss.

- Imported
- Others
- Power Plants
- Industry
- On-road transport
- Non-road transport

- obs
- cmaq

Daily mean contribution in exceedances (MDA8 > 120 µ/m³)
Episode (21-31 July 2012)



MDA8 = maximum daily 8-hour averaged

Exp: sector emissions + imported O_3

Pay et al., 2018. Atmos. Chem. Phys. Diss.

- Imported
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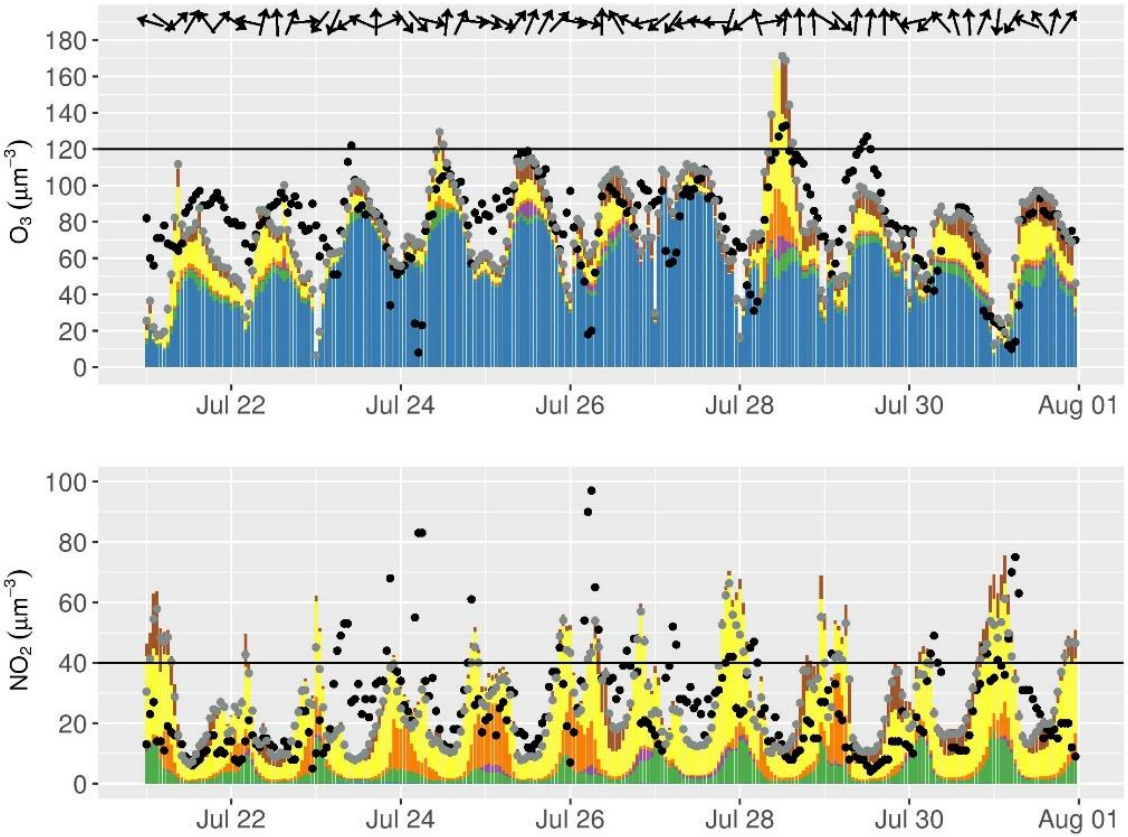
- obs
- cmaq

Receptor: **urban station (3)**



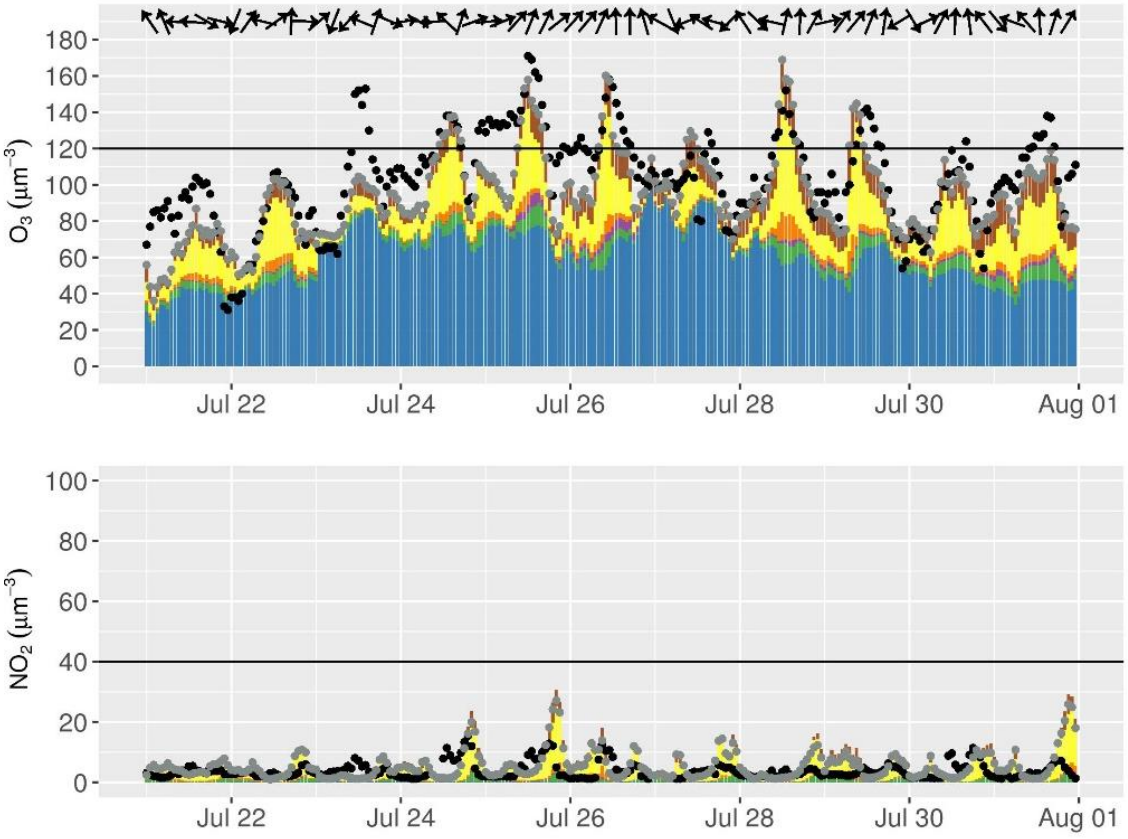
Exp: sector emissions + imported O_3

Pay et al., 2018. Atmos. Chem. Phys. Diss.

- Imported
- Others
- Power Plants
- Industry
- On-road transport
- Non-road transport

- obs
- cmaq

Receptor: **rural station (4)**

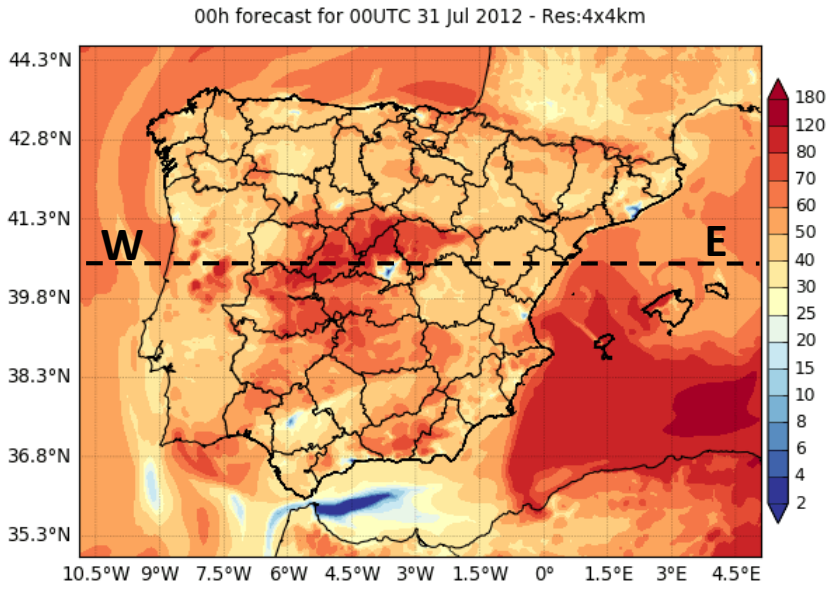


- High model performance at rural background stations (bias = 4.5µg/m^3 and r= 0.7)

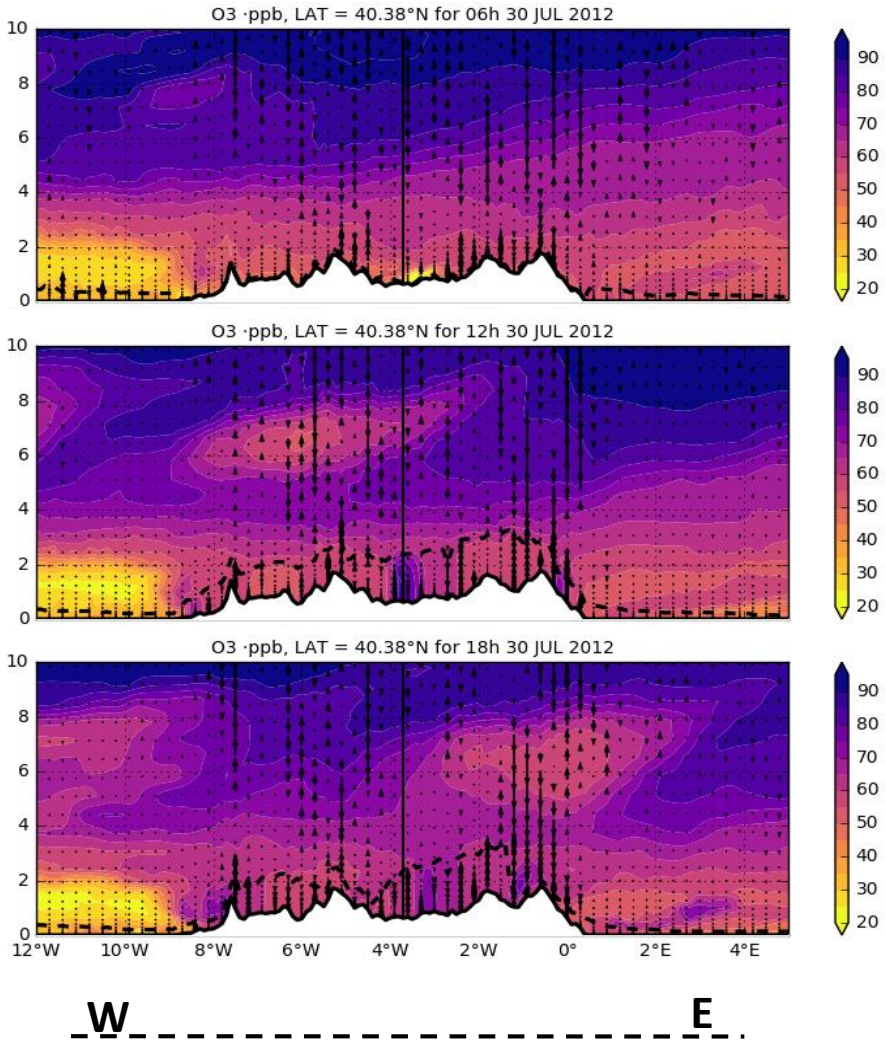
Exp: sector emissions + imported O_3

Pay et al., 2018. Atmos. Chem. Phys. Diss.

Imported O_3

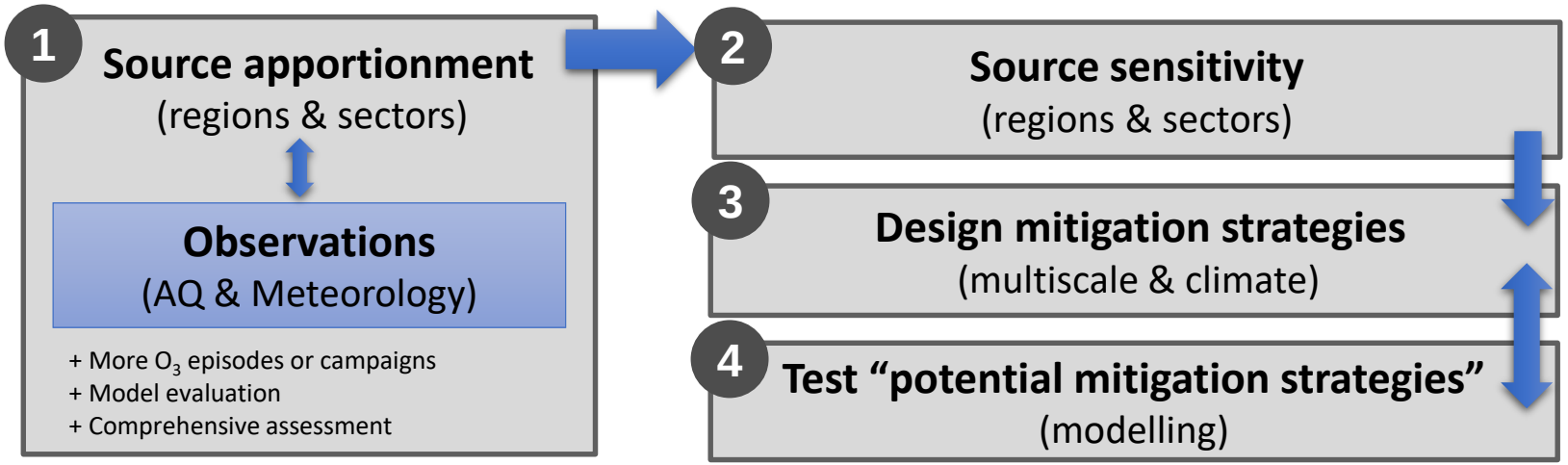


- Main contributor to concentration overall (background levels).
- Processes: advection + vertical mixing.



Conclusions and next steps

- **Regional/local source** contributions dominate O_3 during peaks
  - Next: Identify key emissions sectors.
- **Imported O_3** to the IP is a main contributor to ground-level O_3 concentration overall in summer in Spain (background levels).
  - Next: Quantify the relative importance of imported vs. regional/local O_3.
  - Next: Design mitigation strategies should be coordinated at different scales.
- **Modelled mitigation strategies** have been designed mostly for targeting primary pollutants and the traffic sector.
  - Next: define air quality plan targeting O_3. Main elements:



Thank you!

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RED ESPAÑOLA DE SUPERCOMPUTACIÓN

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

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- Computational Earth Science team - BSC

References:

- Pay, M.T., Gangoiti, G., Guevara, M., Napelenok, S., Querol, X., Jorba, O., Pérez García-Pando, C. *A source apportionment assessment of ozone concentrations in peak summer events over the Iberian Peninsula*. Atmos. Chem. Phys., Diss.